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# The Structural Model of Explaining Social Anxiety based on Behavioral Inhibition/Activation Systems in Adolescent Students: The Mediation Role of Emotion Control

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**Abstract**: This study aimed to investigate the mediating role of emotion control in the relationship between behavioral inhibition/activation systems (BIS/BAS) and social anxiety (SA) in adolescent students. The statistical population of this descriptive correlational study consisted of all adolescent students of the high schools of Tehran, Iran, in 2021. A total of 18 high schools were chosen by cluster sampling to select samples from the educational districts of Tehran. Of these high schools, 564 students were selected through convenience sampling. Research data were gathered using the BIS/BAS scale (Carver & White, 1994), the Social Phobia Inventory (SPIN) (Connor et al., 2000), and Emotion Control Questionnaire (ECQ) (Roger & Najarian, 1989). Finally, structural equation modeling (SEM) was used to analyze the model. The research results indicated an acceptable fit of the structural model with collected data. Also, the findings revealed a significant direct relationship between BIS/BAS with emotion control and BIS and emotion control with SA. Moreover, a significant indirect relationship was extracted between BIS/BAS with SA through the mediating role of emotion control. Overall, it was concluded that the sensitivity levels of BIS/BAS might exacerbate the symptoms of SA by developing maladaptive strategies of emotion control in adolescent students. Therefore, emotion regulation training, taking into account the sensitivity of behavioral brain systems, can be an effective step in preventing and alleviating students' social anxiety.

**Keywords:** Behavioral Inhibition System, Behavioral Activation System, Emotion Control, Social Anxiety

## Introduction

As children enter adolescence, they care more about how they are perceived by peers, friends, and adults and how they should adapt to the social world around them. Although experiencing social anxiety (SA) with an increase in age is a natural part of development, development deviates from its natural process in some adolescents, such that they develop social anxiety disorder (Ollendick et al., 2014). According to epidemiological studies, the prevalence rate of SA symptoms among adolescent students is over 27% (Mekuria et al., 2017), and about 70% of people with SAD experience another mental disorder. The persistence of SA can be a predictor of anxiety disorders, especially generalized anxiety and mood disorders (Mohammadi et al., 2020). In addition, there is a high possibility of using addictive substances as a way to minimize anxiety caused by exposure to social events. Therefore, it is of particular importance to conduct further research on this disorder in adolescents (Davis et al., 2020).

SA is a neurobehavioral trait related to the abnormality of some brain structures, such as the amygdala and the hippocampus. According to genetic studies, this disorder has a hereditary basis (Koç et al., 2018;

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Stein et al., 2017). People suffering from SAD experience more self-focused negative emotions and escape tendencies and exhibit little desire to perform pleasant activities (Gutz et al., 2016). Longitudinal studies show that adolescents with SA symptoms have a stable pattern in personality traits such as behavioral inhibition (Buzzell et al., 2017) and inhibited temperament, which can be recognized from the age of two. They are more likely to experience SA symptoms that are not related to specific fears or performance anxiety (Schwartz et al., 1999). Instead, they experience symptoms emanating from the underlying personality traits that are stable over time and can affect anxiety disorders more than environmental changes. For this reason, research on relatively stable biological factors will play an important role in identifying the fundamental structures of apparent behaviors (McNaughton & Corr, 2008).

Gray's Reinforcement Sensitivity Theory (RST) is a prominent effort to examine the relationship between the function of brain structures and personality traits by presenting a neurological model. This theory explains people's vulnerability to psychological disorders based on three behavioral brain systems that are responsible for controlling behavior in the face of emotional stimuli (Gray, 1982; Gray & McNaughton, 2000). According to this theory, conditioned and innately appetitive stimuli are responded to through the behavioral activation or approach system (BAS). The activity of this system not only increases arousal but also strengthens the ongoing approach behavior. This system is structurally dependent on the frontostriatal system, and the major part of its dopaminergic connections is within the prefrontal lobe (Pickering & Gray, 2001). The next system is the fight-flight-freeze system (FFFS), which is neurologically controlled by the periaqueductal gray matter and is responsible for responding to the threatening and unavoidable conditioned and intrinsic stimuli. The third system, which is related to the septo-hippocampal system and the amygdala, is the behavioral inhibition system (BIS). This system is responsible for resolving goal conflicts in situations where reward and punishment appear simultaneously. In this case, BIS receives environmental information and compares it with previous experiences. If it recognizes the superiority of negative emotional information, it is activated toward avoidance and hinders sensory and motor actions. According to RST, in SAD, the conflict between the appetitive and aversive features of social situations leads to a wider involvement of BIS. As a result, engagement in social activities is prevented by increasing arousal and focusing on aversive stimuli (Gray & McNaughton, 2000).

Previous studies on this theory have confirmed the effect of behavioral brain systems on people's personality differences. Also, they have shown that people with higher psychological well-being have more sensitivity to BAS and less sensitivity to BIS (Sovereign & Walker, 2021). Meanwhile, the sensitivity of BIS to aversive stimuli can predict neurotic disorders such as depression and anxiety better than BAS (Katz et al., 2020). In





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this regard, Amiri *et al*. (2018) investigated the effective factors in the internalizing and externalizing syndromes of adolescent students and found that hyperactivity and hypoactivity of behavioral brain systems can create psychological problems for adolescents, including SA (Amiri et al., 2018). Majdi *et al*. (2020) compared people suffering from SAD with healthy people. The results showed that BIS is positively correlated, and BAS is negatively correlated with the severity of SAD symptoms (Majdi et al., 2020). However, most of the studies on the role of BIS/BAS in SA in non-clinical populations have emphasized the specific relationship of BIS as an important underlying factor in the occurrence of SA symptoms (Gomez et al., 2022; Mahmoud Alilou et al., 2021).

The inability to regulate emotions adaptively is another factor with a special role in the persistence of SA symptoms (Eres et al., 2021; Golmahammadi et al., 2016). Emotion regulation (ER) is a process whereby people make active efforts to manage their moods, stress, and positive and negative emotions. Therefore, people's preferred strategies reveal how they cope with unwanted emotions (Koole, 2009). For example, people who tend to use emotion control strategies often experience intense emotional distress and try to deal with aversive emotions through rumination and emotion suppression (Aldao et al., 2010; Roth et al., 2019). In this respect, Roger and Nesshoever (1989) defined emotion control as the tendency to inhibit the expression of emotional responses and considered it to comprise the four components of rehearsal (rumination), emotional inhibition, aggression control, and benign control. They found that emotional inhibition and rumination were predictors of lower social skills and dissatisfaction with interpersonal confrontations. On the other hand, aggression control and benign control are part of the extroversion constellation with an inverse relationship with impulsive behavior (Roger & Najarian, 1989).

Comparing preferred strategies in psychological disorders indicates that what distinguishes each disorder from another is its unique relationship with specific ER strategies and the robustness of using each. Research has shown that SAD can be distinguished from other anxiety disorders in terms of preferred strategies and severity of emotional dysregulation (Fardaeni Sofla et al., 2015; Schneider et al., 2018). In addition, people with SAD have less psychological flexibility than healthy people (Maarefvand & Shafiabady, 2021) and have a limited capacity to develop ER strategies and control the impulses of anger and hostility (Dixon et al., 2017). Consequently, they must deal with aversive emotional experiences through maladaptive emotion control strategies such as emotion suppression and rumination instead of adaptive strategies (Basharpoor et al., 2020; Maarefvand & Shafiabady, 2021).

Functional Magnetic Resonance Imaging (FMRI) studies indicate that ER methods have a neural basis in brain structures. Expressive suppression is generally associated with increased activity of





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frontoparietal regions (especially the dorsolateral, ventrolateral prefrontal cortices, and inferior parietal cortex) and decreased activity of temporo-occipital areas (Sikka et al., 2022). Also, during reappraisal, the activity of the prefrontal cortex increases while that of the left amygdala stops (Scheffel et al., 2019). On this basis, some researchers have examined the neural bases of ER within the framework of RST. Considering the strong correlation between adaptive and maladaptive strategies and BIS/BAS, they distinguished the path of some ER strategies with reward and punishment response levels in behavioral brain systems (Atadokht & Majdy, 2017; Kelley et al., 2019; Tull et al., 2010). For instance, Kelley *et al*. (2019) studied the relationship between preferred ER strategies and reward responsiveness. According to their finding, at the neurological level, cognitive reappraisal is related to more attention to reward signs. However, emotion suppression is related to anticipation and less reward responsiveness (Kelley et al., 2019). Perchtold-Stefan *et al*. (2021) found that the higher sensitivity of BIS, when combined with the lower sensitivity of BAS, lowers the quantity and quality of adaptive ER strategies (Perchtold-Stefan et al., 2021). Tull *et al*. (2010) also found a positive relationship between BIS and emotion dysregulation and a negative relationship between BAS, especially reward responsiveness and emotion dysregulation (Tull et al., 2010).

Although BIS/BAS plays an important role in explaining the underlying factors of SAD, they are not sufficient to understand how the symptoms of SA persist and exacerbate. Kimbrel is a famous researcher who tried to investigate the developmental and maintenance factors of SAD by proposing an RST-based mediator model. According to this model, the most important vulnerability factor for SAD is genetic predisposition and high sensitivity of BIS. If the initial vulnerability is associated with stressful, stimulating experiences, and low sensitivity of BAS, it will increase inhibition and arousal and lower social performance by creating a cognitive bias toward threatening information. Finally, the intermittent repetition of this cycle intensifies social avoidance and anxiety to the extent that it leads to the development of SAD (Kimbrel, 2008). Conducting many studies based on this model, Kimbrel concluded that BIS is the most powerful system for SA prediction (Kimbrel et al., 2010) and cognitive biases; however, RST could receive more research support when it also deals with the indirect effects of BIS/BAS on SA based on the psychological modulating factors (Kimbrel et al., 2012).

Emotional dysregulation has a meta-diagnostic role in mental disorders (Aldao et al., 2010). In addition, brain neural structures are similar in anxiety's cognitive and emotional components (Gray & McNaughton, 2000). In this respect, some researchers have investigated the mediating role of emotional dysregulation in BIS/BAS and SA. Accordingly, they expand Kimbrel's mediation model and emphasize the effect of avoidance strategies in this disorder. O′Connor *et al*. (2014) found that the severity of SA symptoms can be predicted based on the effect of the low sensitivity of BAS on increasing





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emotional suppression and reducing reappraisal. Besides, they reported that the high sensitivity of BIS could lead to greater SA by reducing the use of reappraisal (O'Connor et al., 2014). By proposing an RST-based model for SA, Ranđelović and Ćirović (2022) argued that rumination plays a significant role in the severity of this disorder by playing a mediating role in the relationship between behavioral brain systems and SA (Ranđelović & Ćirović, 2022). Another study conducted in this regard on the adolescent population indicated that the greater sensitivity of BIS exacerbates adolescents' SA through a greater tendency to experiential avoidance (Papachristou et al., 2018).

Overall, it can be concluded that the interaction of biological and psychological factors plays a significant role in the development and persistence of SAD. The noteworthy point in this regard is that the immature neurobiological brake system in adolescents hinders the development of skills and social relationships required for the transition from this period. Such an immature system makes adolescents more susceptible to SAD than adults by limiting their psychological flexibility, and having a greater tendency to apply emotion control strategies (Tillfors & Zalk, 2015).

The experience of SA acts as a serious obstacle to the development of potential talents, academic success, and social career development of adolescents. Furthermore, it can gradually reduce the possibility of recovery through comorbidity with other psychological disorders and worsening the symptoms. Hence, it is important to investigate the factors affecting adolescents' SA to prevent irreparable future consequences. Reviewing the literature shows that the studies on the mediating role of psychological factors within the framework of RST have been more successful in explaining SA regarding biological factors. However, considering the limited number of mediating studies on cognitive-emotional dysregulation, different findings, and rare research on the adolescent population, the present research seeks to explain SA among Iranian adolescent students by proposing a structural model based on BIS/BAS with the mediating role of emotion control.

## Material and Methods

The present study is descriptive correlational research using structural equation modeling (SEM). The statistical population consisted of all high school students of Tehran, Iran, in 2021. A total of 19 parameters were identified in this study, including 5 paths, 1 covariance error, 2 latent endogenous errors, and 11 indicator errors. According to Raykov and Marcoulides (2012) 30 samples can be considered for each parameter in SEM (Raykov & Marcoulides, 2012). Considering this point and the possibility of drop-out, the initial sample size was estimated to be 600 students, of whom 564 students (302 girls and 262 boys) were included in the final analysis. After receiving permission (86613/53) from the Department of Education of Tehran, based on a letter from Islamic Azad University, we initially




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used the cluster sampling method. We randomly selected 3 districts from the 19 educational districts of Tehran and 18 schools from among the 230 public high schools of that city (three girls' schools and three boys' schools from each district). Considering the virtual education during the COVID-19 pandemic and the impossibility of random selection of students, we made arrangements with the counselors of each school and provided the students with the link to online questionnaires. Then, additional explanations about the objective of the study and how to answer the questionnaires were sent in an audio file to the virtual class groups of the 10th, 11th, and 12th-grade students. This study had the ethics code of IR.IAU.TNB.REC.1400.046 from Islamic Azad University. To comply with ethical considerations, the researchers emphasized voluntary participation in the study and included the subjects in the study after receiving their informed consent. Moreover, to assure the students of the confidentiality of the answer sheets and comply with the principles of confidentiality, they did not ask for the students' personal information (e.g., their first and last names) and used the coding procedure to determine the answer sheets. The inclusion criteria for this study were "giving informed consent for participation in the research" and "being a student in the 10th, 11th, and 12th grades of the selected schools in Tehran". The exclusion criteria were "being in the age group of 15-18 years" and "suffering from physically debilitating diseases and mental disorders that require medication". Therefore, 32 participants were excluded, and the data of 568 students were imported into in SPSS 26 software. Afterward, they were analyzed using the descriptive tests of mean, standard deviation, and correlation coefficients. After checking the normality and multicollinearity assumptions of the research data and considering the need to remove the information of four participants who formed outlier multivariate data, the number of samples was reduced to 564 students. Finally, the model was analyzed using AMOS 24 software and the SEM method.

**Instruments**

**Social Phobia Inventory (SPIN):** This inventory was designed by Connor *et al*. It evaluates the intensity of SA through 17 items based on a Likert five-point scale from 0 = not at all to 4 = extremely and three dimensions of fear, avoidance, and physiological arousal. The designers of this tool calculated its reliability by the retest method in SAD-diagnosed groups to range from 0.78 to 0.89. Also, they calculated its internal consistency in the group without SA symptoms to be 0.94 for the entire scale and 0.89, 0.91, and 0.80 for the dimensions of fear, avoidance, and physiological arousal, respectively (Connor et al., 2000). Hassanvand Amouzadeh *et al*. (2010) investigated the validity and reliability of this scale in Iranian non-clinical samples. They reported its Cronbach's alpha coefficient to be 0.82 in the first half of the test and 0.76 in the second half and calculated the correlation between the two halves as 0.84. They also reported the Spearman-Brown index as 0.91 and Cronbach's alpha coefficients of




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0.75, 0.74, and 0.75 for the dimensions of avoidance, fear, and physiological arousal, respectively. According to these authors, the concurrent validity of the inventory is acceptable based on its significant correlation with the Cognitive Error Questionnaire (CEQ) (0.35), Self-esteem Rating Scale (SERS) (0.58), and Phobic Anxiety in SCL- 90-R (0.70), indicating its satisfactory reliability and validity (Hassanvand Amouzadeh et al., 2013). In the current study, the reliability of this tool was calculated using Cronbach's alpha method to be 0.92 for the entire scale and 0.82, 0.83, and 0.76 for the dimensions of avoidance, fear, and physiological arousal, respectively.

**Behavioral Inhibition System/Behavioral Activation System Scale (BIS/BAS):** Carver & White developed a 24-item self-report tool based on a four-point Likert scale from strong agreement (= 4) to strong disagreement (= 1) to assess people's tendency to avoidance and approach behaviors. Except for 4 items (which were cover questions), 7 items of the scale measure the sensitivity of BIS to aversive stimuli, and the other 13 items measure the sensitivity of BAS to appetitive stimuli through three subscales: drive (4 items), reward responsiveness (5 items) and fun-seeking (4 items). To calculate the tool's reliability, the designers evaluated its

internal consistency and calculated it to be 0.74 for BIS and 0.74, 0.76, and 0.66 for reward responsiveness, drive, and fun-seeking, respectively, as the BAS subscales. As claimed by the designers, the questionnaire's validity was calculated using the test-retest method and reported to be 0.66 for BIS, 0.66 for a drive, 0.59 for reward responsiveness, and 0.69 for fun-seeking (Carver & White, 1994). In Iran, Habibi *et al*. (2019) evaluated the psychometric properties of this scale. They identified that the factor structure of its Persian form confirms the structure of its original form (RMSEA = 1.82 $\chi^2$/df = 0.054). Its Cronbach's alpha coefficient was also reported to be 0.66 for BIS, 0.86 for BAS, and 0.57, 0.78, and 0.63 for the subscales of drive, reward responsiveness, and fun-seeking, respectively (Habibi et al., 2019). The reliability of this tool was calculated using Cronbach's alpha to be 0.73 and 0.72 for BIS and BAS, respectively.

**Emotion Control Questionnaire (ECQ):** Roger and Nesshoever (1987) adjusted the initial structure of this questionnaire, which was later revised by Roger and Najarian (1989). This scale consists of 56 items in four components: emotional inhibition, aggression control, rehearsal or rumination, and benign control. Each component contains 14 items rated based on the correct option (score 1) and the incorrect option (score 0). Roger and Najarian calculated the internal consistency of ECQ using the Kuder-Richardson formula as 0.77, 0.81, 0.86, and 0.79 for the components of emotional inhibition, aggression control, rumination, and benign control, respectively. Also, its validity was confirmed through the significant positive correlation of rumination with neuroticism in the Eysenck personality questionnaire (EPQ), the significant negative correlation of aggression control with the Buss-Durkee scale, and the




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negative and the significant correlation of emotional inhibition and benign control with the extraversion and psychoticism factors of EPQ, respectively (Roger & Najarian, 1989). In Iran, Hasani and Bemani Yazdi (2015) calculated the reliability of this questionnaire through Cronbach's alpha to be 0.72 for the entire scale and 0.71, 0.72, 0.70, and 0.68 for the subscales of emotional inhibition, aggression, rumination, and benign control, respectively. These values indicate the tool's acceptability for the target population (Hasani & Bemani Yazdi, 2015). Using Cronbach's alpha method, the reliability of the dimensions of emotional inhibition, aggression control, rumination, and benign control was calculated in the current study to be 0.69, 0.75, 0.80, and 0.71, respectively.

## Results

The mean and standard deviation of the adolescents' age in this study were 16.11 and 0.75, respectively. About 53.5% (302 students) of the participants were girls, and 46.5% (262 students) were boys. Table 1 presents the mean, standard deviation, skewness, and kurtosis of BIS (1), components of BAS, i.e., drive (2), reward responsiveness (3), and fun-seeking (4), components of emotion control, i.e., emotional inhibition (5), aggression control (6), rumination (7), and benign control (8) and components of SA, i.e., fear (9), avoidance (10), and physiological arousal (11).

According to Table 1, the kurtosis and skewness values of all the components are in the range of ±2, indicating the normality assumption of single variable data distribution. The multicollinearity assumption of the research data was tested using the variance inflation factor (VIF) and tolerance coefficient. According to the results, as the tolerance coefficient of the predictor variables was greater than 0.1 and the VIF of each variable was smaller than 10, the multicollinearity assumption holds between the data (Meyers et al., 2016). The information related to the Mahalanobis distance was analyzed to evaluate the normality assumption of multivariate data distribution. The skewness and kurtosis values calculated for this information were 1.74 and 5.11, respectively. Thus, the kurtosis index for the Mahalanobis distance was greater than 2, and the normality assumption of multivariate distribution among the data did not hold. The box plot

diagram showed that the information related to four participants formed outlier multivariate data. Accordingly, their information was removed from the data, and the skewness and kurtosis values of the data corresponding to the Mahalanobis distance changed to 1.12 and 1.41, respectively.



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**Table 1.** Descriptive indexes of research variables

| Variable | Mean | SD | Skewness | Kurtosis |
|---|---|---|---|---|
| 1 | 19.90 | 4.16 | -.57 | .34 |
| 2 | 12.53 | 2.10 | -.45 | -.13 |
| 3 | 17.69 | 2.20 | -1.20 | 1.66 |
| 4 | 11.67 | 2.27 | -.44 | -.02 |
| 5 | 6.99 | 2.88 | .01 | -.87 |
| 6 | 5.57 | 3.21 | .16 | -.79 |
| 7 | 6.23 | 3.19 | -.21 | -1.03 |
| 8 | 6.21 | 3.09 | .24 | -.76 |
| 9 | 6.58 | 2.17 | .77 | .02 |
| 10 | 8.66 | 2.93 | .64 | -.23 |
| 11 | 4.14 | 2.65 | .95 | .41 |

Table 2 presents the correlation coefficients of BIS (1), BAS components, i.e., drive (2), reward responsiveness (3), and fun-seeking (4), emotion control components, i.e., emotional inhibition (5), aggression control (6), rumination (7), and benign control (8), and the components of SA, i.e., fear (9), avoidance (10), and physiological arousal (11). It is noteworthy that the scoring of the components of aggression control and benign control is reversed in this study. As a result, BIS had a positive correlation, and the drive component of BAS had a negative correlation with all three components of SA. Moreover, the relationship between the two components of BAS, namely reward responsiveness and fun-seeking, with the components of fear and avoidance in SA was negative and significant.

**Table 2.** Correlation matrix of research variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | | | | | | | | | | |
| 2 | -.17** | - | | | | | | | | | |
| 3 | .13** | .40** | - | | | | | | | | |
| 4 | -.03 | .37** | .36** | - | | | | | | | |
| 5 | .19** | -.19** | -.24** | -.11** | - | | | | | | |
| 6 | .24** | -.06 | -.09* | -.03 | .21** | - | | | | | |
| 7 | .40** | -.20** | -.01 | -.04 | .32** | .31** | - | | | | |
| 8 | .35** | -.31** | -.19** | -.12** | .31** | .33** | .40** | - | | | |
| 9 | .46** | -.28** | -.09* | -.10* | .36** | .21** | .44** | .43** | - | | |
| 10 | .37** | -.31** | -.20** | -.16** | .42** | .18** | .41** | ..45** | .68** | - | |
| 11 | .38** | -.20** | -.04 | -.07 | .29** | .15** | .34** | .32** | .63** | .56** | - |

**P < .01, *P < .05

The fit of the measurement model (Fig. 1) was evaluated using confirmatory factor analysis (CFA), AMOS 24 software, and maximum likelihood estimation (MLE). Table 3 shows that the goodness-of-fit indices (GFIs) obtained from the CFA support the acceptable fit of the measurement model with the collected data. In the measurement model, the largest factor loading belonged to the fear indicator (β = 0.931) of SA, while the smallest one belonged to the aggression control indicator (β = 0.412) of emotion control. Since the factor loadings of all the indicators were higher than 0.32, it can be said that they could measure the variables of the current study (Kline, 2015). After evaluating the fit of the measurement model, the GFIs of the structural model were estimated and evaluated. In the structural




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model of the present study, it is assumed that BIS/BAS systems predict SA in adolescents both directly and through the mediating role of emotion control. According to Table 3, the GFIs obtained from the analysis support the acceptable fit of the structural model with the collected data (RMSEA = 0.078, CFI = 0.934, AGFI = 0.905, CFI = 0.944, and $\chi 2/df = 4.47$).

**Table 3.** fit indices of the measurement and the structural model

| Model | $\chi 2$ | df | $\chi 2$/ df | GFI | AGFI | CFI | RMSEA |
|---|---|---|---|---|---|---|---|
| Measurement | 127.79 | 32 | 3.99 | .954 | .922 | .948 | .073 |
| structural | 174.15 | 39 | 4.47 | .944 | .905 | .934 | .078 |

Table 4 shows that the direct path coefficient of BIS with emotion control ($\beta = 0.511$), BAS with emotion control ($\beta = -0.350$), emotion control with SA ($\beta = 0.567$), and BIS with SA ($\beta = 0.167$) was significant ($P < 0.01$), while the direct path coefficient of BAS with SA ($\beta = 0.104$) was not significant ($P< 0.126$). Considering the significance of the indirect path coefficient of BIS ($\beta = 0.290$) and BAS ($\beta = -0.198$) with SA ($P < 0.01$), it was concluded that emotion control has been able to positively mediate the relationship between BIS and SA of adolescents and negatively and significantly mediate the relationship between BAS and SA.

**Table 4.** direct, indirect and total path coefficients in the structural model

| Path | direct effect | Indirect effect | Total effect | b | S.E | p |
|---|---|---|---|---|---|---|
| BIS to Emotion Control | .511 | - | - | .177 | .022 | .001 |
| BAS to Emotion Control | -.350 | - | - | -.358 | .088 | .001 |
| Emotion Control to SA | .567 | - | - | 1.924 | .280 | .001 |
| BIS to SA | .167 | - | - | .196 | .068 | .003 |
| BAS to SA | -.104 | - | - | -.363 | .228 | .126 |
| BIS to SA | - | .290 | - | .341 | .054 | .001 |
| BAS to SA | - | -.198 | - | -.690 | .176 | .001 |
| BIS to SA | - | - | .456 | .536 | .059 | .001 |
| BAS to SA | - | - | -.303 | -1.052 | .203 | .001 |

Fig. 1 shows the structural model of the research, according to which the sum of the square of multiple correlations ($R^2$) for the SA variable was 0.51. As can be seen, BAS, BIS, and emotion control account for 51% of the variance of SA in adolescents.





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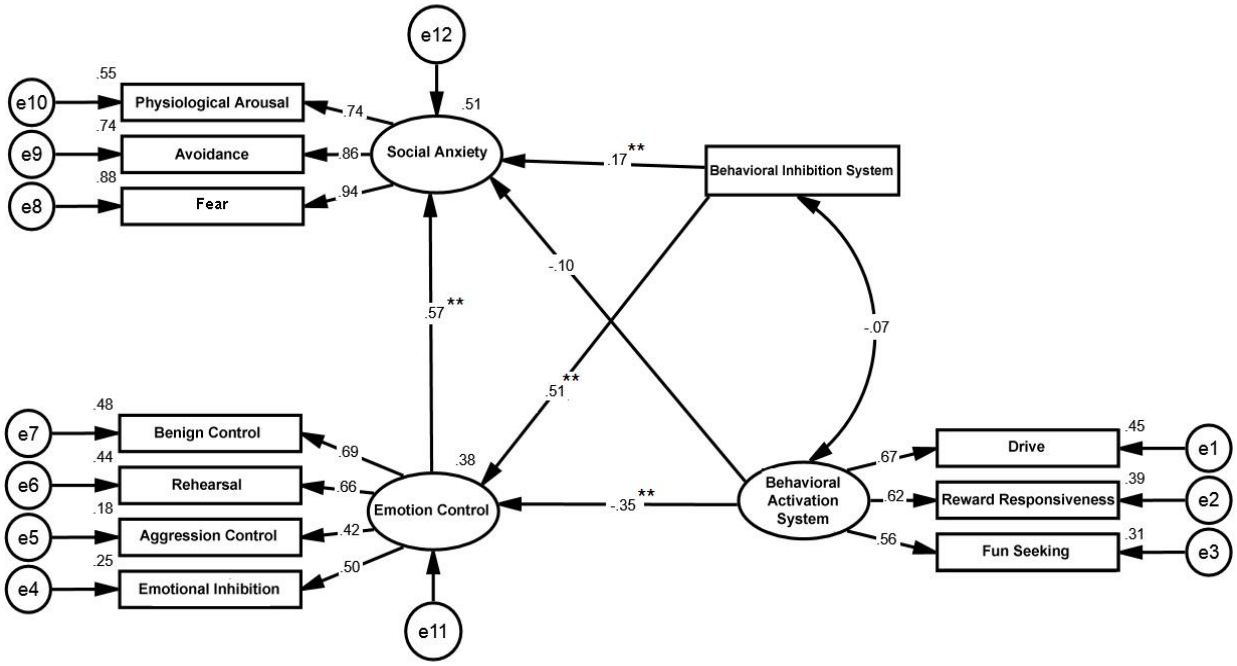


**Fig. 1.** Standard parameters in the structural model of the research

## Discussion

The present study aimed to explain SA in adolescents based on BIS/BAS and the mediating role of emotion control. Its first finding was that the direct effect of BIS on the adolescents' SA was positive and significant, while the direct effect of BAS on their SA was not significant. This result is consistent with the findings of other researchers about the specific relationship of BIS with SA in a non-clinical population (Gomez et al., 2022; Mahmoud Alilou et al., 2021). RST makes it possible to classify the type of personality and the degree of predisposition to psychological problems by examining avoidance and approach behaviors at the neurological level. Accordingly, anxiety disorders increase behavioral inhibition by inherent vulnerability, conditioning of aversive stimuli, and creating abnormality in the activity of the septo-hippocampal system and the amygdala. In SAD, the tendency to behavioral inhibition and avoidance of threatening sources comes into conflict with potential social rewards and increases anxiety. Thus, BIS becomes more active for immediate control of the situation and relieves the arousal caused by goal conflicts by controlling the other brain systems (Gray & McNaughton, 2000). Although biological factors such as the high sensitivity of BIS provide the ground for the emergence of SA symptoms, the transition from childhood to adolescence with the expansion of social comparison and unsuccessful attempts to adapt to new environmental challenges can activate biological vulnerability to SAD. Individual independence to engage in new social situations and gain age-related developmental experiences is a requirement for the psycho-social development of adolescents. Therefore, greater sensitivity to punishment can disrupt the development of social skills by increasing the level of anxiety




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and tendency to experiential avoidance. In addition, it creates greater SA for adolescents by strengthening the brain pathways related to behavioral inhibition (Ollendick et al., 2014; Papachristou et al., 2018).

Another conclusion from the first finding was that BAS has no significant relationship with the SA of adolescents. This result can be explained by the neurological foundations of behavioral brain systems, which connect the brain structures related to sensitivity to punishment and reward with limbic and frontostriatal regions and distinguish them from both functional and neurological perspectives (Adrián-Ventura et al., 2019). On this basis, BIS is a mechanism that is activated to avoid fear or to threaten features of the environment and whose high sensitivity predicts anxiety disorders. Nevertheless, BAS itself engages in a behavioral approach to receive more rewards (Gray & McNaughton, 2000) and is often recognized as a component of well-bein (Atadokht & Majdy, 2017), whose lower activity causes depressive symptoms (Katz et al., 2020). Therefore, BAS alone cannot be considered a biological risk factor for SAD unless the initial genetic vulnerability has engaged the neural structures of BAS due to continuous exposure to threatening stimuli and aversive social experiences (Kimbrel, 2008). A literature review indicates that BAS can predict SA only in people whose SA is more severe in the dimension of social interaction than in that of social observation anxiety (Kimbrel et al., 2010) or who have experienced more severe symptoms due to being in the clinical population (Majdi et al., 2020). The current study was conducted in the non-clinical population of adolescent students, and most similar studies do not consider SA to be predictable through BAS (Gomez et al., 2022; Mahmoud Alilou et al., 2021). Hence, it can be claimed that SA in non-clinical populations can only be predicted through the high sensitivity of BIS, while BAS most likely leads to SA in combination with other factors.

Another finding of this study is that the direct effect of emotion control on the SA of adolescent students was positive and significant. This result is consistent with those of previous studies about a positive correlation between emotional dysregulation and SA (Basharpoor et al., 2020; Dixon et al., 2017; Eres et al., 2021; Golmahammadi et al., 2016; Maarefvand & Shafiabady, 2021). To explain this finding, we can state that experiencing an unwanted emotion and evaluating it as a source of pressure and threat sometimes prompt people to control the expression of emotion. Therefore, the most common method of ER to ignore and hide negative emotions is using emotion control strategies (Roth et al., 2019). Although emotional dysregulation has a meta-diagnostic role in neurotic disorders (Aldao et al., 2010), the relationship of SA with some specific emotional processes can specifically determine the severity of SA in adolescents (Schneider et al., 2018). As one of the most important strategies related to SA, rumination increases anxiety symptoms through repetitive negative thoughts about potential social threats and self-appraisals of performance (Penney & Abbott, 2015). Also, it leads people toward avoidance strategies





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by preventing them from engaging in social activities (Seah et al., 2020). Therefore, emotion suppression, as one of the most common immediate methods of ER to ignore negative emotions and minimize their consequent aversive feelings (Roth et al., 2019), is used with much greater intensity in people with SA symptoms. Besides, it perpetuates the damaging cycle of emotional dysregulation-SA by creating negative emotional consequences and impairment in social functioning. On the other hand, the successful use of adaptive strategies occurs in a positive emotional context. In this situation, social stimuli are perceived as uncontrollable and damaging not only limits the psychological flexibility to use adaptive strategies but also leads to the loss of their emotional usefulness through the inefficient use of adaptive strategies (Dryman & Heimberg, 2018). Hence, SA also greatly reduces the tendency for adaptive strategies such as cognitive reappraisal (Golmahammadi et al., 2016; Maarefvand & Shafiabady, 2021). Besides, although it has no relationship with physical and verbal aggression, it limits the control of anger and hostility (Dixon et al., 2017). In this way, emotional dysregulation creates an ineffective path for coping with emotional disturbances in social situations. Consequently, it disrupts the potential opportunities for adolescents to expand and improve social performance and exacerbates the symptoms of SA.

The present study revealed that BIS predicts emotion control in adolescents positively and significantly, while BAS predicts it negatively and significantly. This finding is consistent with other studies investigating the relationship between BIS/BAS and ER problems (Atadokht & Majdy, 2017; Perchtold-Stefan et al., 2021; Tull et al., 2010). RST describes a state of sensitivity of nervous systems initially related to relatively short-term behaviors and emotions. Based on conditioning and innate predisposition to aversive and reinforcing stimuli, the activity of the behavioral brain systems gradually leads to long-term behavioral and emotional tendencies that describe relatively stable personality traits. In this connection, BAS reacts in the face of appetitive signals that predict pleasure, and it is related to the personality traits of optimism and reward orientation (Pickering & Corr, 2008). Therefore, it prioritizes more adaptive strategies (e.g., cognitive reappraisal) to achieve healthy cognitive, emotional, and social functioning (Cutuli, 2014). On the other hand, it avoids inhibitory strategies that delay pleasure achievement by activating dopaminergic neurotransmitters (Pickering & Gray, 2001). In contrast, BIS acts as a comparator that encourages avoidance behaviors. The neural structure of BIS in the septo-hippocampal system processes the cognitive and emotional components of aversive stimuli through communication with the amygdala, which is the center of emotional memory. As a result, it resolves the conflict through behavioral inhibition if any danger or punishment signals are received (Gray & McNaughton, 2000). In this respect, the successful resolution of goal conflicts requires that BIS inhibits the conflicting behaviors while assessing risk, exploring environmental threat cues, and scanning





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memory. Thus, its over-activity in the long term causes people to constantly search for risk sources that can protect them from threatening stimuli by ruminating about negative events (Pickering & Corr, 2008). On the other hand, sensitivity to anxiety and increased arousal causes people to develop more avoidance strategies to facilitate behavioral inhibition and reduce emotional damage caused by conflicting situations (Papachristou et al., 2018). Finally, not only does the hyperactivity of BIS disrupt the application of adaptive strategies by reducing the expectation of reward at the neurological level (Perchtold-Stefan et al., 2021), but less reward responsiveness can, in turn, predict the development of repressive strategies (Kelley et al., 2019).

The results of testing the general hypothesis of this study demonstrated that emotion control mediates the relationship between BIS and SA in adolescents positively and significantly. In addition, the results showed its mediatory role in the relationship between BAS and SA in the same population negatively and specifically. This finding is consistent with other studies on the mediating role of emotional dysregulation between BIS/BAS and SA (O'Connor et al., 2014; Papachristou et al., 2018; Ranđelović & Ćirović, 2022). Gray's theory on the complex relationship between behavioral brain systems and SAD (Gray & McNaughton, 2000) made psychological researchers think of the psychological processes through which nervous systems influence the development of the symptoms of this disorder and how it is possible to treat a disorder based on its biological characteristics psychologically. In this regard, some researchers have explained SAD by presenting mediation models within the framework of Gray's theory. Consistent with the present study's findings, they have shown that some psychological modulating factors (e.g., cognitive-emotional dysregulation) can significantly increase the predictability of SA through BIS and BAS. To explain this finding, we can state that the biological predisposition to SAD increases the sensitivity of BIS to potentially disturbing social sources. Also, it increases the use of avoidance strategies to cope with emotional arousal by considering social situations as sources of danger (Kimbrel, 2008). Although emotional suppressive strategies are used for the immediate relief of arousal, they endanger social and psychological well-being in the long term (Cutuli, 2014). Additionally, they restrict the opportunity to learn social skills compatible with each developmental period by increasing the symptoms of SA (Maarefvand & Shafiabady, 2021). On the other hand, a continuous increase in aversive social experiences and lack of environmental rewards reduce the sensitivity of BAS to social appetitive stimuli and perpetuate the SA symptoms by developing suppressive strategies (O'Connor et al., 2014). Also, it is of note that adolescents are more exposed to emotional dysfunction than others due to the immature development of inhibitory control neural circuits in the prefrontal and anterior cingulate cortex (Constantinidis & Luna, 2019). The developmental challenges of this period may fail when the initial biological vulnerability to SA intersects with the need to expand social





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experiences and the inadequate development of brain structures in adolescence. Due to limited access to ER strategies, this situation predisposes adolescents to repressive strategies that can increase their degree of SA by establishing defective ER pathways (Papachristou et al., 2018; Tillfors & Zalk, 2015). It is noteworthy that limitations such as convenience sampling and using self-reporting tools through online questionnaires (due to the conditions of the COVID-19 pandemic) may reduce the generalizability of our results. In addition, since the study population was limited to high school students in Tehran, caution should be exercised in its generalization to adolescent students in other grades and from other geographical areas. To gain a profound insight into adolescents' SA from various aspects, future researchers should include more developmental variables. Furthermore, to ensure the generalizability of the study, other psychological assessment tools (such as interviews and observation) should be used. In short, the results of this study supported RST. Also, it expanded the range of studies that have explored the role of psychological factors in mediating the relationship between BIS/BAS and SA by investigating the mediating role of emotion control in adolescents' SA. Since the functioning of behavioral brain systems is manifested through psychological coping strategies, it is suggested to incorporate basic personality differences in developing psychotherapy programs for socially anxious adolescents. It is also suggested to emphasize the importance of underlying biological differences in special training courses for school counselors and officials so that they can prevent adolescents' emotional problems by providing paths that correspond to each person's potential abilities.

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